Gm(A) for driving the display units and touch units of the pixel structures **1412**. The display data driving circuit **1450** is configured to transmit display data to each of the display units through the data lines D**1**(A), D**2**(A), . . . , and Dm(A). The touch data driving circuit **1455** is configured to transmit touch reference data to each of the touch units through each of the data lines D**1**(B), D**2**(B), . . . , and Dm(B), and the touch reading circuit **1440** is configured to read the data stored in each of the touch units through each of the data lines D**1**(B), D**2**(B), . . . , and Dm(B). The switching circuit **1430** connects to the touch data driving circuit **1455** and the touch reading circuit **1440** respectively for switching the touch data driving circuit **1455** and the touch reading circuit **1440** to electrically connect with the data lines D**1**(B), D**2**(B), . . . , and Dm(B) at different time. The comparison processing circuit **1460** connects with the touch data driving circuit **1450** and touch reading circuit **1440** respectively for comparing the data written by the touch data driving circuit **1450** and the data read by the touch reading circuit **1440** to obtain coordinate of the touch position.

FIG. **15** is a timing diagram of signals on each of the gate lines and the data lines in the circuit of FIG. **14**. Referring to FIGS. **14** and **15** together, during each time period, the gate driving circuit **1420** sequentially inputs m pulses to the gate lines G**1**(A)-Gm(A), and, for each pixel, the transistor of the display unit and the transistor of the touch unit are turned on simultaneously. During the N-th time period, the display data driving circuit **1450** transmits the display data to each of data lines D**1**(A), D**2**(A), . . . , Dm(A) for updating the data in each display unit, and in the meantime the touch data driving circuit **1455** transmit touch reference data to each of data lines D**1**(B), D**2**(B), . . . , Dm(B) through the switching circuit **1430** for writing data into each of the touch units. Next, during the (N+1)-th time period, the display data driving circuit **1450** updates the data in each display unit again, and the touch reading circuit **1440** electrically connects with each of the data lines D**1**(B), D**2**(B), . . . , Dm(B) for reading the data stored in each of the touch units. Next, during the (N+2)-th time period, the operation of each circuit element during the N-th time period is performed again, i.e. updating the data in each display unit and writing data into each touch unit. Next, during the (N+3)-th time period, the operation of each circuit element during the (N+1)-th time period is performed again, i.e. updating the data in each display unit and reading the data stored in each touch unit. As described above, coordinate of the touch position can be determined precisely by comparing the touch reference data written during the N-th time period and the data read during the (N+1)-th time period.

It should be noted that the circuit structures and the timing diagrams described above are intended only for illustration, and are not intended to limit the present invention. For example, in the embodiment shown in FIG. **15**, the touch reference data written into each touch unit may be independent of the display data written into each display unit. However, in another embodiment, the touch reference data written into each touch unit may be the same as the display data written into each display unit, i.e. the display data driving circuit **1450** may replace the touch data driving circuit **1455** to write data into the touch units. In still another embodiment, the update frequency of the touch unit can be adjusted according to actual applications. For example, each time after the display unit performs update operation for twice to five times, the touch unit may perform write/read operation only once for reducing the power consumption. In addition, the thin-film transistor matrix substrate can be replaced by a substrate with other type of transistors or switch elements. For example, the CMOS transistor matrix substrate may replace the thin-film transistor matrix substrate for a reflective liquid crystal display.

FIG. **16** illustrates a method for controlling an integrated touch panel LCD device in accordance with one embodiment of the present invention. First, in the step S**1600**, the display data are written into the display units of the integrated pixel structures for updating a display image of the liquid crystal panel. Next, in step S**1610**, the touch reference data are written into the touch units of the integrated pixel structures, wherein the touch reference data can either be the same as or be independent of the display data of step S**1600**. It should be noted that the step S**1600** and the step S**1610** can be performed separately or synchronously, and the operation frequency of each of step S**1600** and step S**1610** can be adjusted respectively based on the type of application. Next, in the step S**1620**, an external force applied on the touch panel LCD device forces the touch unit corresponding to the touch position to discharge, and the voltage value stored in said touch unit is reduced accordingly. Next, in step S**1630**, the reference voltages stored in touch units of each pixel structure are read, and, in some embodiments, the operation frequency of the step S**1630** can be varied with that of the step S**1610**. Next, the procedure goes back to the step S**1600**, the display units are updated and the touch units are written and read again; meanwhile, the procedure also proceeds to step S**1640**, a logical computation on the data written and read in step S**1610** and step S**1630** respectively is performed. In the step S**1640**, the computation can be performed individually on each touch unit, such that the multi-touch function can be achieved. Furthermore, a threshold value can be set in advance for determining the degree of the force applied on the touch panel LCD device and filtering out the adverse noise. Next, in step S**1650**, the coordinate, touch area, and pressure on the touch position can be determined based on the result of the logical computation.

The integrated touch panel LCD device of the present invention can adopt one-layer structure, whereby the whole thickness can be reduced 30%-50% comparing with the conventional plug-in touch panel LCD device. The one-layer structure can avoid color non-uniformity defects (Mura), such as the Newton ring effect. Therefore, the present invention has advantages of small size, thin thickness, lightweight, and high reliability. Furthermore, the present invention can identify the locations of multiple points simultaneously and suppress noise by reading the data stored in the embedded touch units and performing comparison process, which can assure the accuracy of the touch position.

While this invention has been described with reference to the illustrative embodiments, these descriptions should not be construed in a limiting sense. Various modifications of the illustrative embodiment, as well as other embodiments of the invention, will be apparent upon reference to these descriptions. It is therefore contemplated that the appended claims will cover any such modifications or embodiments as falling within the true scope of the invention and its legal equivalents.

I claim:

1. An integrated pixel structure, comprising:

a transistor matrix substrate;

a color filter substrate disposed above the transistor matrix substrate, the color filter substrate being substantially parallel with the transistor matrix substrate; and

a liquid crystal layer interposed between the transistor matrix substrate and the color filter substrate,

wherein the transistor matrix substrate comprises:

a first transistor;

a first storage capacitor connected to the first transistor;